New Improved Window Technique for Iris Segmentation

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Abstract—**This paper present a new improved window technique for iris segmentation. It's a most important step for iris segmentation which required before iris matching It is a novel approach which comprise two step, pupillary detection and edge detection. In first step pupillary detection, it finds the pupils' center and then two radial coefficients because sometime pupil is not perfect circle. The second step edge detection it extract the information of the pupil center and find edges on one-dimensional imaginary line to each side of the pupil. By experiments it conclude that other existing techniques like automatic segmentation algorithm gives 84 percent accuracy while window technique gives 99 percent accurate results for Pupil boundary and 79 percent for iris edge detections in presence of high degree of eyelashes and eyelids covering the iris region.**

Keywords- Iris Segmentation; Pupillary boundary; Edge detection; Iris basis; Feature extraction.

I. INTRODUCTION

Biometric refers to the identification & verification of human identity based on certain physiological trait of a person. Iris recognition is regarded as a high accuracy verification technology, so that many countries have idea of adopting iris recognition to improve safety of their key departments. The iris is the pigmented colored part of the eye behind the eyelids and in front of lens. It is the only internal organ of the body which is normally externally visible. These visible patterns are unique to individuals and it has been found that the probability of finding similar pattern is almost 'ZERO'.

Iris recognition methods are classified into four categories; the Phase based method [2] the zero crossing representation based method [3] the texture based method [4] & local intensity variation [6].
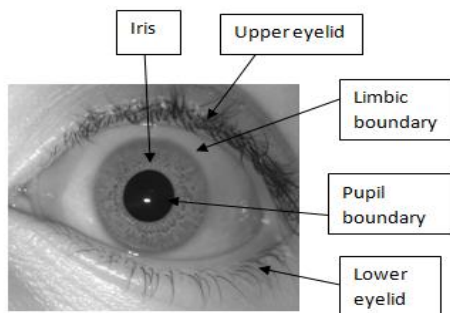

Figure 1. Human Eye Structure

Daughman's [1] system is based on the use of 2-D Gabor filters as cardiac waves to extract phase information. Second method uses the Bernoulli trials to fit the interclass distribution after phase quantization. Zero crossing method represents the One-Dimensional wavelet transform at different resolution of concentric circles. In this method, measures the energy difference between two zero crossing representation of iris image. Iris recognition system includes certain steps i.e. iris collection, preprocessing, segmentation, normalization, feature extraction and pattern matching. Lim et al[5] also use the wavelet transform to extract feature from the iris region. Zero crossing method represents the One-Dimensional wavelet transform at different resolution of concentric circles. In this method, measures the penergy difference between two zero crossing representation of iris image. Boles and Boashash [3] make use of 1D wavelets for encoding iris pattern data. Huang et al. [7] proceeded to iris segmentation by simple filtering, edge detection and Hough transform. This method is specifically proposed for removing eyelash and pupil noises. Nakissa [8] has presented a new algorithm for iris localization. The exact location of iris can be detected using an iterative algorithm based on the active contour models. Narote et. al[9] have proposed one such modification to determine an automated threshold for binarization based on histogram. Shamsi[10] gives a improved Daughman algorithm to improve the speed of the system.

II. PREPROCESSING STEPS

A. Image Acquisition:

First step of iris recognition system is captured iris region of the human eye image. It is used before the segmentation of iris and common for both methods. Because eye iris is very small and black object so it must be captured at a short distant about 4cm to 13 cm under a good illumination environment. The objective iris image may have undesired portion of eyes like sclera, eyelid, pupil, the area of this is also a dependent parameters on eye to camera distance & angle of camera. To improve the quality of iris images preprocessing steps are required. In this paper, we have used CASIA database for experiments.

III. IRIS SEGMENTATION- WINDOW TECHNIQUE

A. Pupillary boundary

In this paper, CASIA database eye image is used for the experiment. To find the pupil, we first need to apply a linear threshold in the image, Where, I is the original image and g is the threshold image. If intensity of Pixels greater is than the empirical value of 70 (in a 0 to 256 scale) known as dark pixels, therefore converted to 1 (black). Pixels intensity is smaller than or equal to 70 are assigned to 0 (white). Next, we apply Freeman's chain code to find regions of 8-connected pixels that are assigned with value equal 1. There is also a possible to see that eyelashes also satisfy the threshold condition, but its area is smaller than the pupil area. Using this knowledge, we can cycle through all regions.

Finally, we apply the chain code algorithm in order to retrieve the only region in the image (i.e. the pupil). From this region, it is trivial to obtain its central moments. Finding the edges of the pupil involves the creation of two imaginary orthogonal lines passing through the centroid of the region. The binarized pupil boundaries are defined by the first pixel with intensity zero; from the center to the extremities. It is very efficient and reliable method.

B. Iris edge detection

In this step of iris segmentation, finding the contour of the iris. The first problem comes from the anatomy of the eye and the fact that every person is different. Sometimes the eyelid may occlude part of the iris and not perfect circle may be assumed in this case. Other times due to variation in gaze direction the iris center will not match the pupil center, and we will have to deal with strips of iris of different width around the pupil.

We are considering that areas of the iris at the right and left of the pupil are the ones that most often present visible for data extraction. The areas above and below the pupil have unique information, but there is a possibility that they are totally or partially occluded by eyelash or eyelid. A technique adopted for iris detection which use the information from pupillary boundary section to trace a horizontal imaginary line that crosses the whole image passing through the center of the pupil. We analyze that the signal composed by pixel intensity from the center of the image towards the border and try to detect abrupt increases of intensity level. Although the edge between the iris disk and the sclera are smooth and it has greater intensity than iris pixels. We intensify this difference applying a linear contrast filter. There is possibility of sudden rise in intensity because some pixels inside the iris disk are very bright. So, detection of iris edge at that point gets fail. To prevent that from happening, we take the intensity average of small windows and then detect when the sudden rises occur from these intervals.

The following steps taken to detect the edges of the iris image I(x,y).

- With papillary boundary algorithm, find the center (x_{cp}, y_{cp}) of the pupil and the pupil radius r_x and then apply a linear contrast filter on image $I(x,y)$: $G(x, y) = I(x, y).\alpha$

- Create vector $V=\{v_1, v_2, ..., v_w\}$ that holds pixel intensities of the imaginary row passing through the center of the pupil (r_x), with w being the width of contrasted image G(x,y).

- Create vector $R=\{r_{xcp+ rx r}, r_{xcp+ rx + 1}, ..., r_w\}$ from the row that passes through the center of the pupil (y_{cp}) in contrasted iris image G(x,y). Vector R formed by the elements of the y_{cp} line that start at the right fringe of the pupil ($x_{cp}+rx$) and go all the way to the width (w) of the image. Experiences shown that adding a small margin to the fringe of the pupil provides good results as it covers for small errors of the "findpupil" algorithm.

- Similar as described above, create vector $L=\{l_{xcp-rx}, l_{xcp-rx-1}, ..., r_1\}$ from row (y_{cp}) of G(x,y). This time we are forming vector L which contains elements of pupil center line starting at the left fringe of the pupil and ending at the first element of that line.

- For each side of the pupil (vector R for the right side and vector L for the left side):

➢ Calculate the average window vector $A=\{a_1, ..., a_n\}$ where n=|L| or n=|R|. Vector A is subdivided in i windows of size w_s. For all window $i_1^{n/ws}$, elements $a_{i.ws-ws}...a_{i.ws}$ will contain the average of that window. We found through experiments that a window size $ws=15$ provides satisfactory results for the CASIA Iris database.

➢ Identify the edge point given side of the iris (vector L or R) as the first increase of values in A_j ($1 \leq j \leq n$) that exceeds a set threshold t. In our experiments, a value of t equal to 10 has shown to identify the correct location of the iris edge. The advantage of this algorithm is performance. For an image of size $m.n$, the complexity is O($m.n$) for the contrast operation and O(m) for edge finding, total complexity of O($m.n$). The reader must be warned though that algorithm efficiency and reliability highly depends on carefully chosen threshold (t) and window size (ws). Other modifications to the algorithm may also help improve the overall accuracy of the algorithm for instance adding margins to the sides of the pupil.

Fast computation comes with a price, and the algorithm is very sensitive to local intensity variation (or lack of).

C. Feature extraction

So far we have performed the segmentation of the iris in two steps to reduce the size of vector pattern and to isolate only information that distinguishes individuals, namely the iris patterns. Reduced size of iris pattern is required because the CASIA Iris Database provides images that are 320x280 i.e. 89,600 pixels. This dimension is too high for today's computing power, and even though we had such capacity, and it also not gives the satisfactory results.

D. Forming iris basis: overall Strategy

Iris Basis is our first attempt to reduce the dimension of the eye image and focused only one part of the eye that effectively identify the desired part. Also, we are restricted to map only those areas of iris which has less influence of eyelashes and eyelids. Assuming that intra-class rotation of iris is practically void, we propose an approach, reduce the size of the iris image

and extract pixels of either side of the pupil The overall strategy is as follows: given image, desired number of Iris Basis rows and columns,

- Retrieve pupil center, radius and iris endpoints.

- Calculate height of pupil (2 times radius) and space between rows (*s*) as pupil height divided by desired number of Iris Basis rows.

- Calculate index of the first target row as center of pupil – vertical pupil radius, assuming that first row is at the top of the image.

- For each side of the pupil, find baseline width as iris edge of current side – pupil edge of current side.

For all baselines, starting at the top of the pupil, ending at the bottom of the pupil and spaced by *s*, perform the following steps

- Calculate, using the equation of the circle, the (x,y) location of pixel that resides in the intersection of current baseline and circle centered at pupil center with radius equal to pupil horizontal radius.

- Map pixels that are under the baseline to vector B with number of elements equal to half of desired number of columns. Use an average mask of 3x3 pixels to calculate pixel intensity.

- Append vector B to Iris Basis matrix of respective side of the iris.

- Merge the two halves of Iris Basis matrices side by side into one final Iris Basis matrix.

This is an attempt to avoid eyelashes and eyelids. The final result of classification will depend only on texture features are in samples. This algorithm considers only those features to the sides of the pupil.

IV. EXPERIMENTAL RESULT

The proposed algorithm is tested on CASIA iris image database [12]. There are 756 iris images from 108 different irises. For each eye, 7 images are captured in two sessions. The resolution of the iris image is 320×280 pixels. Pupillary detection section of this algorithm gives 99 % accurate detection of pupil boundary, pupil's center and radial coefficients. Iris detection part of this algorithm gives 79 % accuracy in case of high degree of eyelash overlapping and eyelids covering part of the iris or the sclera was not as white as expected. Fig. 2 to Fig. 5 shows the segmentation results of second approach.
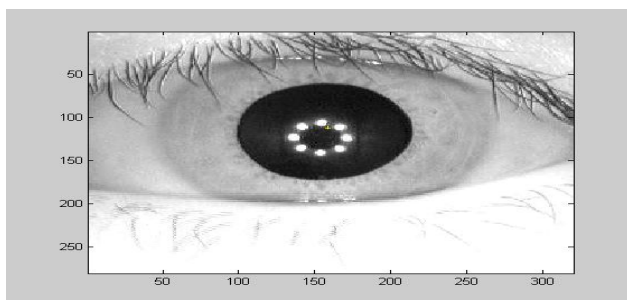

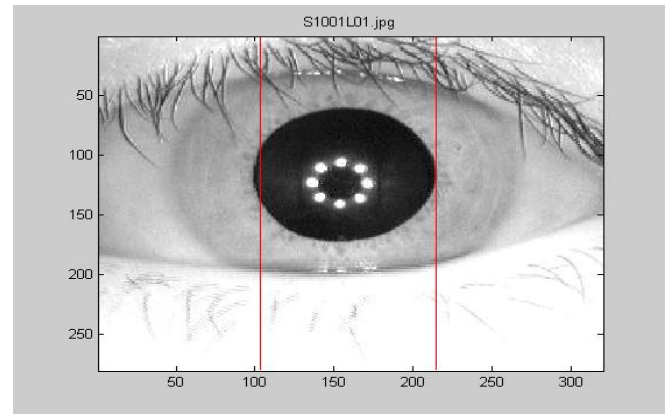Figure 2. Pupil finder(Find the pupil center)

Figure 3. Cycles through all images of the database and gives the final count of segmentation successes or failures
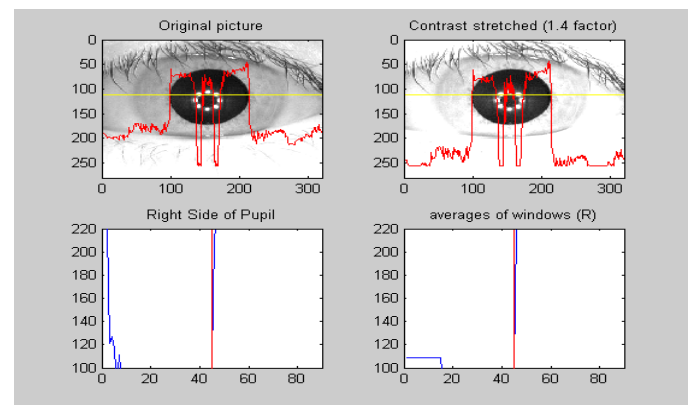

Figure 4. Iris finder (perform image segmentation and finds the edge points of the iris at the horizontal line that crosses the center of the pupil)
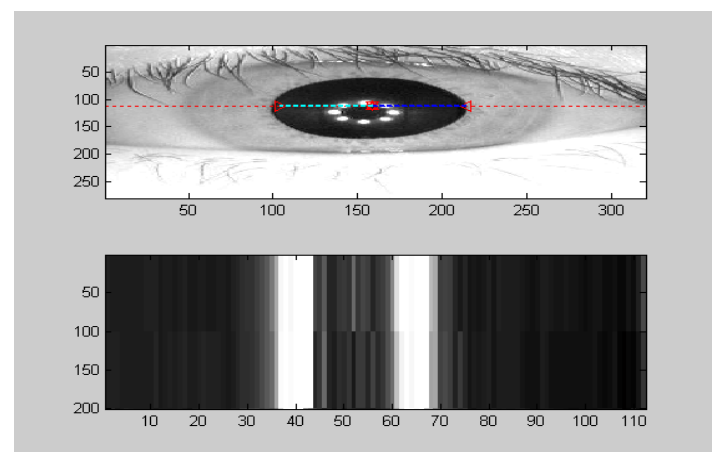

Figure 5. Iris basis construction & visualization

V. CONCLUSION

In this paper we proposed a window technique for image segmentation for isolation of the iris and posterior extraction of fundamental classification data. We faced some problems inherent of imaging the Human Eye, as interference of eyelashes and eyelids over the iris. Depending on the illumination scheme, light speckles may also affect the amount of epigenetic material visible to the classification system. The algorithm designed to extract the fundamental information of the iris is also a re-sampling algorithm, as it is possible to choose an output dimension of the picture (*IrisBasis*) smaller than its original size and the algorithm will use a 3x3 averaging

mask to perform re-sampling. We must keep in mind that the average iris diameter noted in the CASIA Iris database is 230 pixels, and the iris strip can vary anything between 30 pixels and 80 pixels wide. If we resample down the number of pixels too much, we will lose vital epigenetic information and have worst classification results. In our tests, we used 40x40 pixels *IrisBasis* images. Transforming such image into a patter vector leaves us with a vector of 1601 elements per instance (including the class label element). This vector still contains a great number of redundant information, and pre-processing methods must be applied.

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